

**DEPARTMENT OF TRANSPORTATION**  
**DIVISION OF ENGINEERING SERVICES**  
Transportation Laboratory  
5900 Folsom Blvd.  
Sacramento, California 95819-4612



## METHOD FOR DETERMINING PERCENTAGE OF CRUSHED PARTICLES

**CAUTION:** Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "SAFETY AND HEALTH" in Part 11 of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

### A. SCOPE

This test describes a procedure for determining the percent, by weight, of particles that, by visual inspection, have the characteristics of crushed aggregate.

### B. SIGNIFICANCE AND USE

Some specifications contain requirements relating to percentage of crushed particles in coarse aggregates. One purpose of such requirements is to maximize shear strength by increasing inter-particle friction in either bound or unbound aggregate mixtures. Another purpose is to provide stability for surface treatment aggregates and to provide increased friction and texture for aggregates used in pavement surface courses. This test method provides a standard procedure for determining the characteristics of coarse aggregate with respect to such requirements.

Specifications differ as to the number of fractured faces required on a crushed particle, and they also differ as to whether percentage is based on total weight of aggregate or based on particle count. If the specification does not specify, use the criterion of two or more fractured faces and calculate percentage by weight.

It is the intent of this test method to only determine the percent of crushed

particles created by the crusher operation from an aggregate source and not the additional crushed/fractured aggregates created by laboratory processes. With this in mind, it is important that the tester handle aggregates for this test carefully.

### C. TERMINOLOGY

*Crushed Particle:* Any particle having two or more fractured faces. A fractured face is an angular, rough or broken surface of an aggregate particle created by crushing or by other mechanical means. The face shall also need to have sharp and well-defined edges excluding small nicks. A fractured face shall be determined a "fractured face" only if the projected surface area of the fractured face is at least 25 % of the largest cross-sectional area of the aggregate.

### D. APPARATUS

1. *Balance:* Any balance or scale with a capacity of at least 6000 g and sensitive to 0.1 g or less. Balance or scale calibration must be traceable to N.I.S.T. (National Institute of Standards Technology).
2. *Sample Splitting Device:* Any device that will produce a representative split sample and that will not alter the aggregates from their

original shape. Riffle splitters are the preferred devices.

(Refer to California Test 125 – Part 1, Notes 2 and California Test 201 - Section H.)

3. *Spatula*: One of sufficient size to separate aggregates on a flat surface (Optional).
4. *Sieves*: Standard sieves shall be of the woven-wire type with square openings and shall conform to AASHTO Designation: M 92.



5. *Magnifying Glass*: Mechanical arm type that has a light and is affixed to a stationary object so the tester does not need to hold the magnifying glass while examining the aggregates (Optional).
6. A facility to accommodate the removal of moisture from wet samples. When air-drying is not practical, typical equipment may be a fan with or without heating coils or a vented forced air oven capable of maintaining a temperature of  $230 \pm 9^\circ\text{F}$ . When testing reclaimed aggregates containing traces of asphalt, the oven drying temperature shall not exceed  $100^\circ\text{F}$ .

## E. SAMPLE PREPARATION

1. Separate the test sample into a series of sizes using such sieves as are necessary to determine compliance with the specification for the material being tested using the mechanical sieving method.
2. Prepare the sample as described in California Test 201. From each coarse aggregate fraction representing 5 % or more of the submitted sample, split a representative portion to within 10 % of the weight specified in Table 1.

**TABLE 1**

Coarse Aggregate Fraction (Passing by Retained)			Test Sample Weight, in g ( $\pm 10\%$ )	
2"	by	1½"	.....	6000
1½"	by	1"	.....	3000
1"	by	¾"	.....	1500
¾"	by	½"	.....	1000
½"	by	⅜"	.....	500
⅜"	by	¼"	.....	250
¼"	by	No. 4	.....	100

\*If ½" and/or ¼" sieves are not required, use the following:

¾"	by	⅜"	.....	1200
⅜"	by	No. 4	.....	300

Aggregates that have an accumulation of fines should be carefully washed on the No. 4 sieve by hand and then dried to a constant weight before performing this test. If the sample to be washed is too large for the sieve, wash it in separate small portions then recombine them to get a constant weight.

3. If the percent of crushed particles for the portion passing the No. 4 sieve and retained on the No. 8 sieve material is required (i.e., when stated in specifications or when determination of percentage of crushed particles is

not limited to the material retained on the No. 4 sieve and the No. 4 by No. 8 aggregate fraction represents more than 5 % of the submitted sample), split a representative portion of the material passing the No. 4 sieve large enough to yield  $100 \pm 10$  g of material retained on the No. 8 sieve. Waste the fraction passing the No. 8 sieve.

## F. TEST PROCEDURE

1. Weigh each test sample to the nearest gram (g) and record as "Test Sample Weight."
2. Spread one of the test samples on a clean flat surface in a well-lit area large enough to permit the material to be spread thinly for inspection.
3. Use the knife-edge of a large spatula or similar tool to separate uncrushed particles from crushed particles. Any particle having two or more fractured faces as defined by this test method shall be considered a crushed particle.
4. When the separation is complete, weigh the crushed particles and record as "Weight of Crushed Particles."

5. Repeat the above procedure on each test sample representing an individual size fraction.

Table 2 is an example illustrating a typical calculation for the coarse (retained No. 4 sieve) portion of a sample.

## G. CALCULATIONS

1. Calculate the percent of crushed particles in each respective test sample using the following formula:

Percent of Crushed Particles =

$$\left[ \frac{\text{[(Weight of Crushed Particles) / (Test Sample Weight)]} \times 100}{\right]$$

2. Calculate the percent of crushed particles in the whole or in the coarse portion of the as-received sample by the weighted average method as follows:

Multiply the percent of each size fraction to be included in the weighted average by its respective percent of crushed particles (use the total weight of the as-received sample). The sum of these products divided by the sum of the percent of each of the included size fractions (based on the total weight of the as-

Table 2 – Example Calculation						
	A	B	C	D	E	F
Size Fractions (Passing by Retained)	Cumulative % Passing	Individual % Retained	Weight of Sample (Table 1)	Weight of Crushed Particles	% Crushed Particles (D/C)* 100	Ind. % Retained × % Crushed (B*E)
3" by 2"	100	0	-	-	-	-
2" by 1½"	97	100-97=3*	-	-	-	-
1½" by 1"	77	97-77=20	3000	2610	87	1740
1" by ¾"	70	77-70=7	1500	1335	89	623
¾" by ⅜"	51	70-51=19	1200	1116	93	1767
⅜" by No. 4	35	51-35=16	300	285	95	1520
	Total	20+7+19+16 = 62	-	-	Total	5650
Crushed Particles = $5650/62 = 91\%$ (Total F) / (Total B)						

\*Less than 5 % fraction in as-received sample – no test.

received sample) gives the weighted average percent of crushed particles for that group of fractions included in the calculation.

#### **H. PRECAUTION**

If the dust film obscures the surface and makes it difficult to detect fractured particle faces, wash and oven-dry the aggregate sample.

#### **I. REPORTING OF RESULTS**

Report the weighted average test results to the nearest 1 %.

#### **J. SAFETY AND HEALTH**

Aggregates may contain bacteria and/or organisms that can be harmful to one's health. The wearing of dust masks and protective gloves when handling materials is advised.

Prior to handling, testing or disposing of any materials, testers are required to read the following portions of Caltrans Laboratory Safety Manual: Part A, Section 5.0, Hazards and Employee Exposure; Part B, Sections: 5.0, Safe Laboratory Practices; 6.0, Chemical Procurement Distribution and Storage; and 10.0, Personal Protective Apparel and Equipment; and Part C, Section 1.0, Safe Laboratory Practices. Users of this method do so at their own risk.

#### **REFERENCES:**

**AASHTO Designation: M 92**

**ASTM D 5821**

**California Tests 125 and 201**

**End of Text**

**(California Test 205 contains 6 pages)**



Crushed Particle  
(chip > 25% of largest cross-section)



Crushed Particles  
(chip > 25% of largest cross-section)



Not Crushed Particles  
(rounded river rock)



Not Crushed Particles  
(one fractured face)

**California Test 205 - Calculation Sheet for Crushed Particle Count**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>
<b>Size Fractions</b> (passing by retained)	<b>Cumulative Passing</b>	<b>Individual % Retained</b>	<b>Weight of Sample</b> (Table 1)	<b>Weight of Crushed Particles</b>	<b>Percent Crushed Particles</b> (D/C) * 100	<b>Individual % Retained X % Crushed</b> (B*E)
3" by 2"						
2" by 1½"						
1½" by 1"						
1" by ¾"						
¾" by ⅜"						
⅜" by No. 4						
	Total				Total	
<b>Percent Crushed Particles</b> (Total Column F / Total Column B)						= _____

\*Less than 5 % of fraction in as-received sample – no test.